

# Spread of an Invasive Plant on Alaska's Roads and River Floodplains: A Network Model

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## Abstract

Alaska has few invasive plants, and most of them are found only along the state's limited road system. One of the most-widely distributed invasives in the state, *Melilotus alba*, or sweetclover, has been sown both as a forage crop and as a roadside stabilization species. *Melilotus* has recently been found to have moved from roadsides to the floodplains of at

least three glacial rivers: the lower Stikine, the Matanuska and the Nenana. We are building a network model to examine the spatial relationships between roads, river crossings and downstream public lands of high conservation significance in Interior and Southcentral Alaska. As a case study, we are documenting the distribution of *Melilotus* near river crossings. In 2005, we surveyed 120 bridges along five major highways. When considered together, the distribution data and the network model will identify certain river crossings as critical control points for preventing the movement of *Melilotus* toward particular lands downstream. Moreover, the network model has the potential to function as a general tool to identify present and future critical control points upstream from land units being managed by a variety of different agencies, and for any future invasive species that can disperse via roads and river networks in Alaska.

## Introduction

Alaska has few invasive plants. The state's isolation, lack of development and cold climate limit the introduction and success of many invasive species. Invasive species often disperse along road networks (Gelbard and Belnap 2003, Lugo and Gucinski 2000, Parendes and Jones 2000), and Alaska has only 0.02 miles of road per square mile of land area (0.01 km of road per km<sup>2</sup>), compared to California's 1.08 miles per square mile (0.67 km of road per km<sup>2</sup>) (Alaska DOT 2002).

*Melilotus alba*, or sweetclover, has recently become a species of concern in Alaska. *Melilotus* is widely distributed along roadsides around the state, a result of both intentional sowing as a roadside stabilization species, and unintentional transport of seed via contaminated soil and gravel. *Melilotus* has been found along the park roads in Denali National Park and Preserve and adjacent to other national parks in Alaska, lands of unquestionably high conservation value (Densmore et al. 2001). Notably, *Melilotus* has aggressively colonized the floodplain of the lower Stikine River in Southeast Alaska, the lower Matanuska River in Southcentral Alaska, and the upper Nenana River in Interior Alaska (Figure 1). It is likely that *Melilotus* spread onto the floodplains from roads, mines, and agricultural developments upstream. Though many of Alaska's most pristine public lands are located off the road system, they may be vulnerable to invasion by species that gain access to river floodplains from upstream roadside environments.

This project has two objectives. First, we are building a network model to understand the spatial relationships between roads, rivers and public lands of high conserva-



Figure 1. Three rivers (the Stikine, Matanuska and Nenana Rivers) whose floodplains are known to have been colonized by *Melilotus alba*.

tion value in Interior and Southcentral Alaska. Second, we are documenting the current distribution of *Melilotus alba* on roadsides and river floodplains near bridges in the same area. We use the *Melilotus* distribution data as a case study in the application of the network model, to identify critical control points for preventing its spread to conservation units downstream.

## Methods

### The network model

The network model is supported by several GIS data layers. The river network is modeled using the National Hydrography Dataset (NHD) (USGS 1999); the Alaska Department of Transportation GPS centerline dataset provides a detailed road network (Alaska DOT 2006); and the boundaries of federal and state land designations were obtained from an Administrative Boundaries dataset (Alaska DNR 2001). We started with the assumption that all migration of invasive plants on the river system would be downstream. We then utilized the NHD as our base layer for river networks, since it covers the entire state at a fine scale (1:63,360), and also incorporates a flow network. There is no comprehensive road network dataset available for Alaska, but the Alaska Department of Transportation (AKDOT) provided a draft version of a new GPS road centerline network. It covers the contiguous highway system plus Kodiak and Cordova. Some roads are not included in this dataset—for example, the Denali Park road, state-administered logging roads and private roads—but this road data is the best currently available. We began with the land classification boundaries identified on the Administrative Large Parcel Boundaries dataset, produced by the Alaska Department of Natural Resources (Alaska DNR 2001). We refer to that list of parcel types in aggregate as “conservation units.”

We defined “crossings” as intersections between the NHD-derived streams and rivers network, and the AKDOT road centerline network. NHD sub-region 1904 (the Yukon River drainage) yielded a total of 919 crossings. Crossings identified in the Alaska Milepost, an annually



USDA Forest Service photo by Blaine T. Spellman

*Melilotus* growing on the roadside of the Parks Highway, near its crossing of Bear Creek.



USDA Forest Service photo by Tricia L. Wurtz

A first-year *Melilotus* plant on the Matanuska River floodplain.



USDA Forest Service photo by Blaine T. Spellman

*Melilotus* growing along the bank of the Tanana River, at a place where the river parallels the Richardson Highway.



USDA Forest Service photo by Tricia L. Wurtz

*Melilotus alba* (white flowers) growing with another invasive plant, birdvetch (*Vicia cracca*) along a Fairbanks roadside.



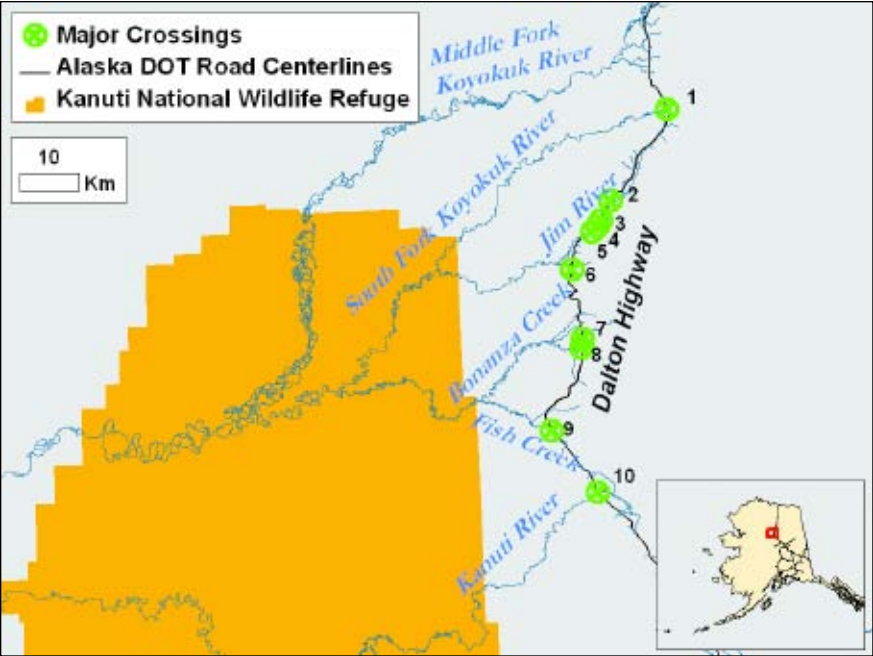


Figure 2. Roadsheds were defined as a group of nearby crossings and their immediate connecting downstream waterways. The major crossing identification numbers shown here correspond to numbers in Table 1.

updated book on Alaska Highways (Morris Communications 2005), and generally corresponding to bridges along major highways, are referred to as “major crossings”. All others are considered “minor crossings”. “Roadsheds” are a group of nearby crossings and their immediate connecting downstream waterways. To identify the conservation units within each roadshed, river flowlines were buffered by 328 feet (100 m) and were then intersected with the Administrative Large Parcel Boundaries.

A case study using *Melilotus alba*

In summer 2005, we visited crossings of portions of five highways in Interior and Southcentral Alaska. These sections of highway included a total of 233 crossings as

derived from the NHD. We surveyed the 120 major crossings that were described in the Milepost, and which were represented on the landscape by a bridge or large culvert. At each crossing, we collected both quantitative and qualitative data on the amount of *Melilotus* occurring on natural floodplain surfaces at the crossing. Each downstream floodplain surface in the vicinity of a sampled crossing was characterized based on its apparent vulnerability to invasion by *Melilotus*. For example, densely vegetated surfaces were given a score of low, while bare silt or gravel floodplains were considered high in their vulnerability to invasion. We also made qualitative assessments of the amount of *Melilotus* occurring on the roadside in the vicinity of the bridge. Places where *Melilotus* was a substantial component of the vegetation on the roadside were given a ranking of high, while places where *Melilotus* was present only as widely scattered individuals were given a ranking of low.

For the purposes of this paper, we have used the Kanuti National Wildlife Refuge as an example, since its roadsheds are entirely located in sub-region 1904, and while it has no direct road access, it is close to one of the surveyed highways. In 2005, we surveyed the 10 southernmost major

Number on Fig. 2	Highway	Milepost	Crossing Name	Distance to Kanuti (km)	Upstream	Downstream	Roadside	Invasability
1	DALTON	156	S FORK KOYUKUK RIVER	80	NONE	NONE	LIGHT	HIGH
2	DALTON	144	JIM RIVER 3	52	NONE	NONE	NONE	HIGH
3	DALTON	142	DOUGLAS CREEK	46	NONE	NONE	NONE	LOW
4	DALTON	142	JIM RIVER 2	45	NONE	NONE	NONE	MOD
5	DALTON	140	JIM RIVER 1	42	NONE	NONE	NONE	LOW
6	DALTON	135	PROSPECT CREEK	36	NONE	NONE	LIGHT	LOW
7	DALTON	125	N FORK BONANZA CREEK	50	NONE	NONE	MOD	LOW
8	DALTON	124	S FORK BONANZA CREEK	47	NONE	NONE	LIGHT	MOD
9	DALTON	113	FISH CREEK	27	NONE	NONE	LIGHT	MOD
10	DALTON	105	KANUTI RIVER	38	NONE	NONE	LIGHT	LOW

Table 1. Major crossings of the Dalton Highway that lead to the Kanuti National Wildlife Refuge. “Milepost” refers to state highway milepost markers nearest the crossing. The “Distance to Kanuti” column gives the total river distance in kilometers from the Dalton Highway to the eastern boundary of the refuge. The last four columns give data collected in 2005 as part of our *Melilotus* survey.

crossings along the Dalton Highway in the Kanuti Roadshed, because as we worked north, *Melilotus* had disappeared from the roadsides at about Milepost 150.

## Results

### *The network model*

We have completed compiling the roadsheds for NHD sub-region 1904. The roadshed identification process is currently underway for the portion of NHD Region 1902 that comprises the Matanuska and Susitna River watersheds. When both sub-regions are complete, we will link both sets of roadsheds together, and relate them to conservation unit boundaries.

### *A case study using *Melilotus alba**

Of the ten major crossings we surveyed in the roadsheds leading to Kanuti National Wildlife Refuge, none had *Melilotus* on a natural floodplain surface either upstream or downstream of the crossing. Six had *Melilotus* on the roadside immediately adjacent to the crossing. We characterized five of the crossings as moderately or highly vulnerable to invasion by *Melilotus* (Table 1).

## Discussion and conclusions

The network model is a work in progress. We are currently working to link the roads, crossings, reaches, roadsheds and conservation units so that the data can readily be summarized based on any of these factors, and so that an end-user can identify a feature (for example, a national park or a national wildlife refuge) and the crossings, upstream road segments and river reaches that are associated with it.

## Management implications

In our example with Kanuti National Wildlife Refuge, we identified six major crossings where *Melilotus* was found on the roadside immediately adjacent to the bridge (Figure 2). One of these crossings was ranked as highly vulnerable to invasion, and two were ranked as moderately invasable. Refuge managers will be able to prioritize monitoring and



***Melilotus* seedlings growing in silt on the floodplain of the Matanuska River.**

control efforts based on these results, thereby reducing the vulnerability of the refuge to the introduction of *Melilotus* via its upstream river networks. Future research could examine the characteristics of different floodplain substrates that may make them more or less vulnerable to colonization by a variety of different invasive plant species.

Taken together, the network model and the case study are an effective means of identifying certain river and stream crossings as critical control points for preventing the movement of *Melilotus* toward particular lands downstream. Moreover, when it is complete, the network model will function as a generally applicable tool to identify the critical control points upstream from land units being managed by a variety of different agencies, and for any future invasive species that can disperse via roads and river networks in Alaska.

## Acknowledgements

We thank the USDA Forest Service, R10 State and Private Forestry for funding and assistance with the mapping components of this project.

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